The version 2.0 MRO MARCI MDGM is generated one mission subphase at a time. The production procedure involves the following steps.

(1). Download the MRO MARCI EDR images for the mission subphase from the PDS. Split each image into individual filters. Calculate image backplanes (incident angle, emission angle, phase angle, latitude, and longitude) using SPICE toolbox.

(2) Apply radiometric calibration to convert Data Number (DN) to physical unit following the procedure described in the “marcical.txt” file in the MARCI PDS archive. Remove down-track “stripes” due to pixel-to-pixel variation.

(3). For each filter, derive an averaged radiometrically processed image. Use the averaged image to derive parameter values for the following photometric function through non-linear least-squares fitting.

$$r(i,e,g,x) = \frac{\mu_0}{\mu+\mu_0} \cdot H(\gamma,\mu_0) \cdot H(\gamma,\mu) \cdot [f \cdot G(k_1,g) + (1-f) \cdot G(k_2,g)] \cdot$$

$$\left[1 + \frac{B_0}{1+h_1 \cdot \tan(g/2)} + \frac{a_1}{\exp(g/\alpha)}\right] \cdot (b_0 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4)$$

Where, i is incidence angle, e is emission angle, g is phase angle, x is the cross-track pixel number, $\mu_0 = \cos(i), \mu = \cos(e)$, $H(\gamma,\mu) = (1+2\mu)/(1+2\gamma\mu)$, $G(k,g) = (1-k^2)/(1+k^2+2k\cos(g))^{3/2}$ is the Henyey-Greenstein phase function. The derived parameter values $(\gamma, k_1, k_2, f, B_0, h_1, a_1\ \alpha, b_0, b_1, b_2, b_3, b_4)$ are listed in the photoparam/ folder for each filter. Perform photometric correction. I.e., each radiometrically calibrated pixel from Step (1) is divided by the value calculated using the equation above.

(4). For each filter, derive an averaged photometrically processed image swath for each resolution. All UV images have 128 samples per line. For visible images, a mission subphase usually contains two resolutions – (a) 1024 samples per line and (b) 512 samples per line. Occasionally, there are not enough images of one resolution or the other within the mission subphase to generate the averaged image. When this happens, images of the same resolution in adjacent mission subphases are combined to calculate the average.

One or both bright polar cap(s) in the averaged swath are sometimes removed by extrapolating from the regolith area near the cap edge toward the pole.

Divide each image swath from Step (3) by the averaged swath. This normalization is designed to further “flatten” the brightness variation due to viewing geometry.

For UV swaths, semi-manually crop out the area with severe anomalies and smooth out residual along-track stripes.

(5). For each pixel of the image, calculate the weight to be used to merge image swaths into MDGMs. The weight is based on the sum of the incidence angle, emission angle, and phase angle. Larger weight is assigned to smaller sum. Pixels with extreme geometry near the north and south terminator cause apparent anomaly in MDGM. Therefore, they are assigned to zero weight.

(6). Organize MARCI images into different days. Each day contains data obtained within 13 consecutive MRO orbits. Make daily mosaic for each filter using the image processed through Step (4), the weight in Step (5), and the latitude and longitude backplanes calculated in Step (1). For visible bands, make both 0.1 degree and 0.05 degree MDGMs. Since the resolution of UV swath is about 8 km/pixel at nadir, we only make 0.1 degree MDGMs for band6 and band7.

(7). Make RGB color MDGM by combining band4, band2 and band1 (or band3, band2 and band1 when band4 is unavailable).